

SEXUAL DIMORPHISM OF TAIWAN BAMBOO VIPERS¹

SHOU-HSIAN MAO²

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The Taiwan bamboo vipers were grouped by Maki (1) into 3 different subspecies, employing the relationship of colored stripes on sides of the body as the criterion for differentiation. These were given as: *Trimeresurus gramineus stejnegeri* (with a white lateral stripe on sides of the body), *T. gramineus formosensis* (with both white and red lateral stripes on sides of the body), and *T. gramineus kodairai* (without any lateral stripes). Later, Wang & Wang (2) and Chen (3) adopted Maki's classification in their writings. However, Pope (4) expressed the opinion that all 3 subspecies classified by Maki belonged to the same subspecies *T. stejnegeri stejnegeri*. He believed that *T. gramineus formosensis* was the male form of *T. stejnegeri stejnegeri* and *T. gramineus kodairai* only a variation of *T. stejnegeri stejnegeri*. Keegan (5) stated that the classification of *T. poperum*, *T. stejnegeri*, *T. gramineus* and *T. albolabris* was not entirely clear. The purpose of this study is to clarify classification for the bamboo vipers in Taiwan.

MATERIALS AND METHODS

A total of 116 specimens were collected from September 8, 1959 to August 23, 1961. Two of these were obtained from Taipei; 55 from Kuan Yin Shan, in suburb of Taipei; 4 from Neihu, 12 miles northeast of Taipei; 1 from Ping Tung, 20 miles east of Kao Hsiung; 1 from Heng Chung, the southernmost tip of this island; 1 from Chia Yi Hsien, in the southern part of Taiwan; and 52 from I-Lan Hsien, in the northeastern part of Taiwan (Fig. 1). A specimen in the Dept. of

Zoology, National Taiwan University, collected by Takahashi in 1924 and named *T. gramineus kodairai* (No. T. 39 ♀) was also examined. Seven embryos from 2 mothers were also studied.

After specimens were brought to the laboratory, they were killed with chloroform. Each specimen was carefully measured for total length (from snout to tip of tail) and tail length (from vent to tip of tail). The base of the tail was split open along the mid-ventral line to determine the sex. Particular attention was paid to the variation of the lateral stripes on the males and females. Neutral formalin (sodium phosphate monobasic 4.0 g, sodium phosphate dibasic 6.5 g, formalin 100 ml, and distilled water 900 ml) was used for preservation of specimens.

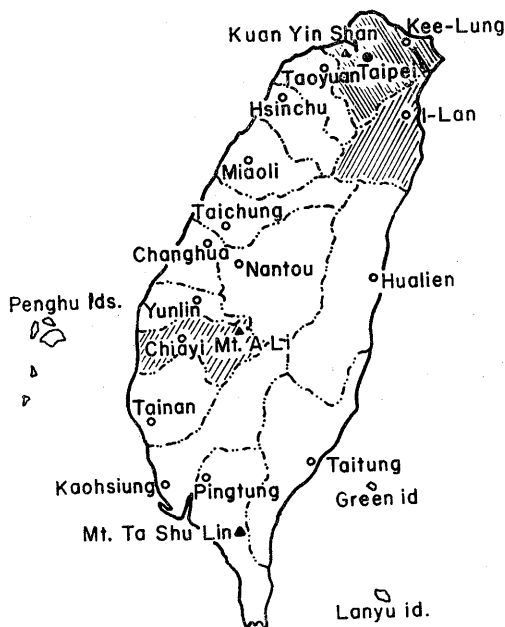


Fig. 1. Map of Taiwan showing collection localities of *Trimeresurus stejnegeri stejnegeri*.

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2 Lecturer, Department of Biomorphics, National Defense Medical Center, Taipei, Taiwan.

RESULTS

Scale Characteristics and Measurements

The nasal scales are usually flat and entire. However in specimen No. 181♂ they are divided longitudinally on both sides by a suture in front of the nostrils. All the internasals are small, separated by 2 small apical scales, occasionally 1 or 3, very rarely 4; supraoculars narrow, separated by 11 or 12 scales, occasionally 10 or 13, very rarely 14; internasal separated from supraocular by 4 scales, very rarely 3 or 5; upper labials 9 or 10, rarely 11, very rarely 8, the first completely separated from nasal by a suture, the 3rd generally in broad contact with the subocular, very rarely with narrow contact, or not in contact at all; one series of scales between subocular and upper labials; lower labials 11 or 12, occasionally 13, very rarely 10 or 14, anterior 3 in contact with anterior chin-shields; preoculars invariably 2; postoculars 2, occasionally 3, very rarely 1 or 4; generally 1 or 2, very rarely none, scales present between nasal and anterior pit shield; scales strongly keeled, usually in 23 rows on the neck, occasionally 25, rarely 21, 21 at mid-body and 15 before vent; ventrals in 83 males 153-173, in 31 females 155-174; subcaudals in 81 males 63-78; 30 females 57-75; anal entire. The above descriptions are based upon the observation of 116 specimens, including 2 half-grown females.

The ventrals, subcaudals and measurements of total length and tail length are tabulated in Table I.

Sexual Dimorphism and Variation in Lateral Stripes

In 116 specimens collected, there are 83 males with both white and red lateral stripes, and 33 females with white lateral stripe only. The lateral stripes are variable in both sexes.

Female Specimens

The white lateral stripe in 23 of 33 females occurs along the middle line of the first outer scale row, and in 10 females it extends onto the upper half. In 32 specimens the anterior extension of the white stripe ends at the following 3 locations: 1) in 12, it reaches to the eye (Fig. 2); 2) in 2, to the angle of the jaw; 3) in 18, to the neck and in 2 of these it is very vague above the middle line in the neck region. One specimen (No. 224♀) bears a trace of white on the middle line of the first outer scale row in the posterior 1/5 on both sides of body. White is lacking completely on the anterior part on both sides of the body, whereas, at mid-body of the left side, in addition, it is further spotted with vague white near the base of each scale but the right side is without any white spot at all. The specimen No. T. 73♀, designated by Takahashi as *T. gramineus kodairai* and considered without a white stripe on sides of the body by Maki, was examined by the author. A trace of white line was found on the first outer row on each side before the vent. It is similar to specimen No. 224♀, except for an absence of white on the left side at mid-body.

TABLE I

Summary of ventrals, subcaudals and measurements of the adult Taiwan Bamboo Vipers

	Sex	No. of specimens	Extremes	Average
Ventrals	♂	83	153-173	163
	♀	31	155-174	164.5
Subcaudals	♂	81	63-78	70.5
	♀	30	57-75	65
Total length	♂	81	46.7-72.9cm	59.9cm
	♀	30	43.1-74.8cm	58.9cm
Tail/Length	♂	81	0.17-0.21	0.19
	♀	30	0.15-0.18	0.17

Male Specimens.

The white lateral stripe in 77 of 83 males extends over the upper half of the outer scale row, whereas, on the remaining 6, it runs along the middle line of outer row. The red lateral stripe in 49 males occurs along the middle line of outer row of scales and on the lower half of it in the remaining 34 (Fig. 3).

As in the females, the anterior end of the white lateral stripe in 82 specimens also extends to 3 different locations: 1) in 69, it reaches to the eye; 2) in 11, to the angle of the jaw; and 3) in 2, to the neck. In specimen No. 249♂ the white stripe above the middle line of the outer row is very faint and hardly visible in the neck region. Rarely, the scales of the second outer row possess a margin of white on the lower edge.

The red lateral stripe is even more variable than the white one, especially in specimens with the red stripe running above the middle line of the first outer row. The variations of the red stripe are as follows: 1) The red stripe along the middle line of the outer row is very light or faint in the anterior portion, distinct at the middle and posterior parts of the body (Fig. 4); 2) it is indistinct in the anterior and middle parts but distinct at posterior part of body; 3) the red stripe above the middle line or lower half of the first outer row is restricted to the posterior part and is distinct in color, however, in one specimen it is reduced to a trace of red before the vent (Fig. 5); and 4) in one specimen the red stripe along the middle line of the outer scale row extends to a point about 4-head lengths from the neck.

In addition, the lateral stripes were also studied in the fully developed embryos. One gravid specimen bears distinct white lateral stripe, carrying 13 undeveloped eggs and 4 fully developed embryos. Three of the embryos, measuring 20.1 cm, 20.2 cm and 21.3 cm respectively, were females with well developed white lateral stripes, 1 was a male with marked white and red lateral stripes, measuring 20.1 cm.

DISCUSSION

Of the specimens examined, all males bear both white and red lateral stripes, while the females bear the white lateral stripe only. This indicates that there is a sexual dimorphism in *Trimeresurus stejnegeri stejnegeri*. A fully developed embryo, dissected out of a mother with a white stripe only, possesses both white and red stripes. This further proves that these lines

represent sexual characteristics rather than subspecific differences.

The red stripes are apt to lose color when preserved in formalin. A rather light shade may fade away completely within 2 weeks. Therefore, it is necessary to examine living or freshly killed snakes for accurate observation of the red lateral stripes.

Maki (1) stated that *T. gramineus stejnegeri* (with the white lateral stripe only) was distributed on northern Taiwan and *T. gramineus formosensis* (with white and red lateral stripes) on southern Taiwan, extending to northern Taiwan. He also inferred that an intergradation may be expected to occur between two forms in northern and central Taiwan. Judged upon the 116 specimens collected in the past 2 years, the *T. gramineus formosensis* of Maki is distributed widely in northern Taiwan. Accordingly the so-called intergradation Maki inferred is certainly the variation of the red stripes as stated above. It is apparent that Maki interpreted sexual differences in coloration as representing a different subspecies.

Specimen No. 224♀ is evidently the variation of *T. stejnegeri stejnegeri*, since outer scale row on the left side bears very weak white spots at mid-body, and the posterior part of the body also shows a trace of white line on both sides. This is a gravid specimen, carrying 13 undeveloped eggs and 3 advanced embryos, measuring 12.9 cm, 13.8 cm and 14.2 cm respectively. Unfortunately the embryos were not yet pigmented, therefore, it is difficult to judge whether the white stripe the mother bears at the most posterior part of her body is inheritable.

The specimen collected by Takahashi, and named *T. gramineus kodairai*, also shows a trace of white at the most posterior part of the body, therefore, it should be considered a variation of *T. stejnegeri stejnegeri*. This variation apparently can be found in bamboo vipers in southern, central and northern Taiwan, since specimen No. 224♀ was collected from I-Lan Hsien, in the northeastern part of Taiwan, and the Takahashi's specimen from Makazayazaya (in Ping Tung Hsien), in the southern part of Taiwan.

SUMMARY AND CONCLUSIONS

Trimeresurus stejnegeri stejnegeri exhibits marked sexual dimorphism. In both sexes there is a white lateral stripe along the middle line or upper half of the first outer scale row. In male, there is an additional red lateral stripe located

just below the white. Regardless of the shades of coloration and length of the red stripe, it is an important characteristic of the male form of this subspecies.

The anterior extension of the white stripe represents another sexual characteristic. In males, the white stripe generally extends anteriorly to the eye, whereas in females, it often ends about the neck. Usually the white stripe runs over the upper half of the first outer scale row in the male and on the middle line of it in the female. Hence the location of the white line may be another indication of sexual dimorphism of snakes in a given locality.

The nasal scale in Taiwan bamboo vipers is entire, flat and not divided by suture. Findings of this study indicate that the bamboo vipers found in southern, central and northern Taiwan all belong to *T. stejnegeri stejnegeri*.

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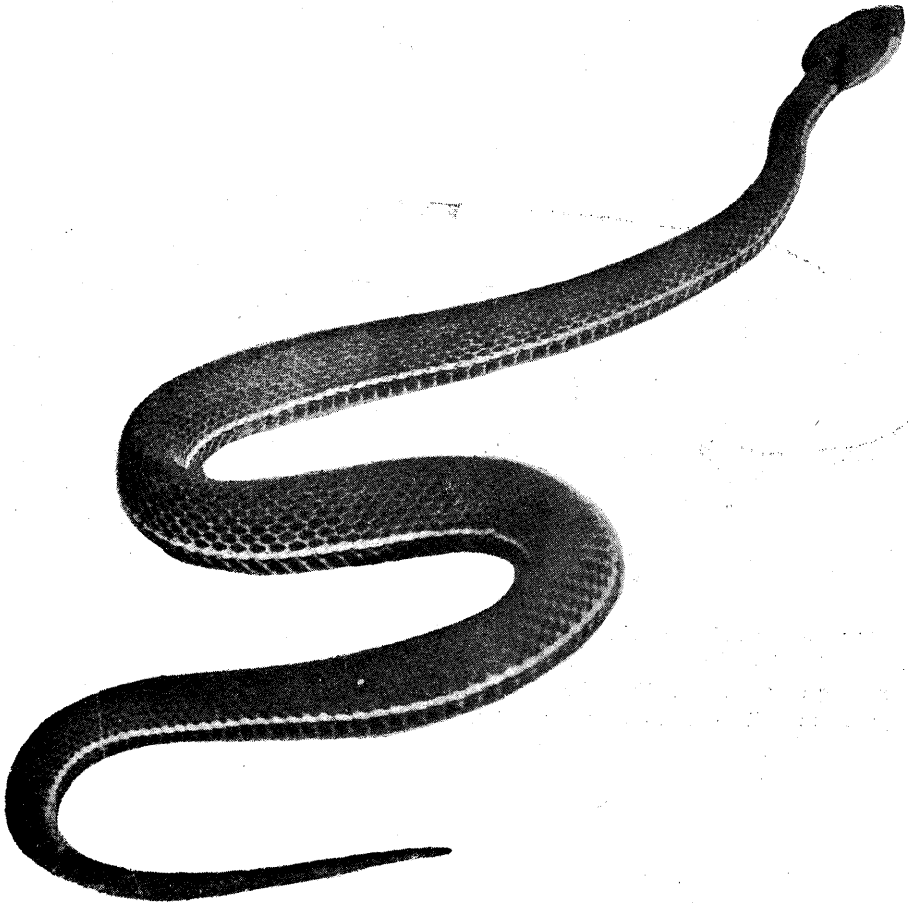


Fig. 2. Lateral view of *T. stejnegeri stejnegeri* showing white lateral stripe extending over the upper half of outer row of scales and anteriorly to the eye (No. 204 ♀).

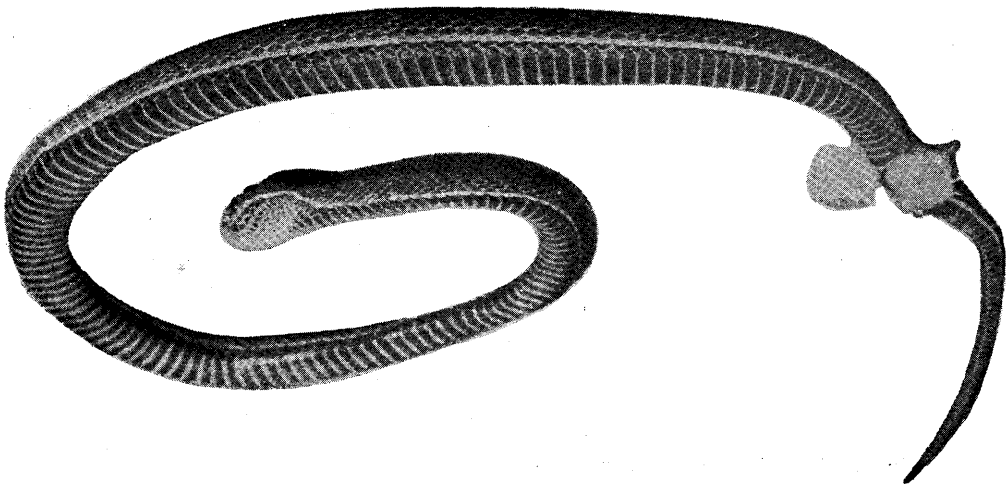


Fig. 3. Ventral view, showing lateral stripes. White stripe extends over the upper half of outer row of scales and anteriorly to the eye, and the red one (black in fig.) occurs on lower half of outer scale row to the neck (No. 180 ♂).

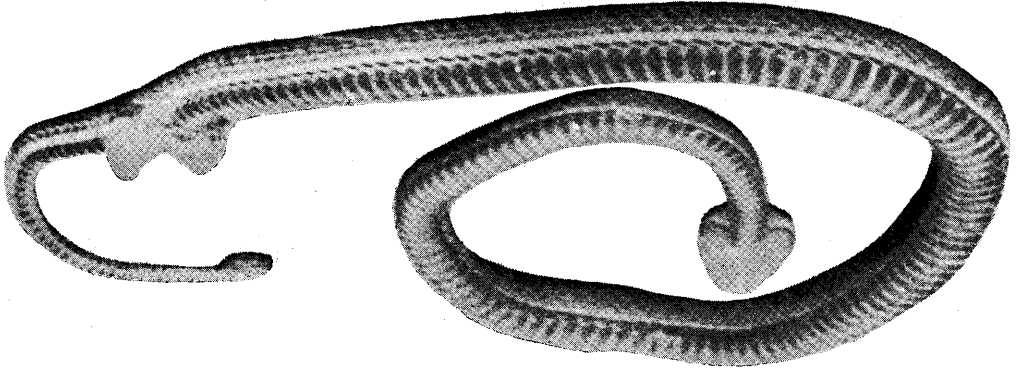


Fig. 4. Ventral view, showing lateral stripes. The white stripe extends over the upper half of outer row of scales anteriorly to the eye, the red one (black in fig.), stretching on the middle line of outer scale row, is almost colorless in anterior portion, distinct at middle and posterior parts (No. 179 ♂).

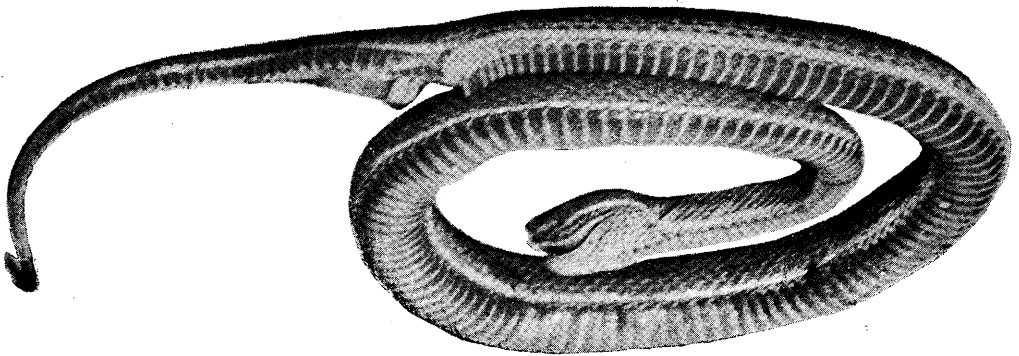


Fig. 5. Ventral view, showing lateral stripes. The white stripe extends over the upper half of outer scale row anteriorly to the eye, the red one (black in fig.) is very faint along the middle of outer row of scales and restricted to the posterior part of the body. The black spots under the white stripe are green in anterior and middle parts of the body (No. 177 ♂).